

# Visual Odometry for Autonomous Deep-Space Navigation

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HAT: 4.5.a, 4.7.a, 5.4.b TA: 4.6 Autonomous Rendezvous and Docking

TRL: start 3 / current 5

## OVERVIEW

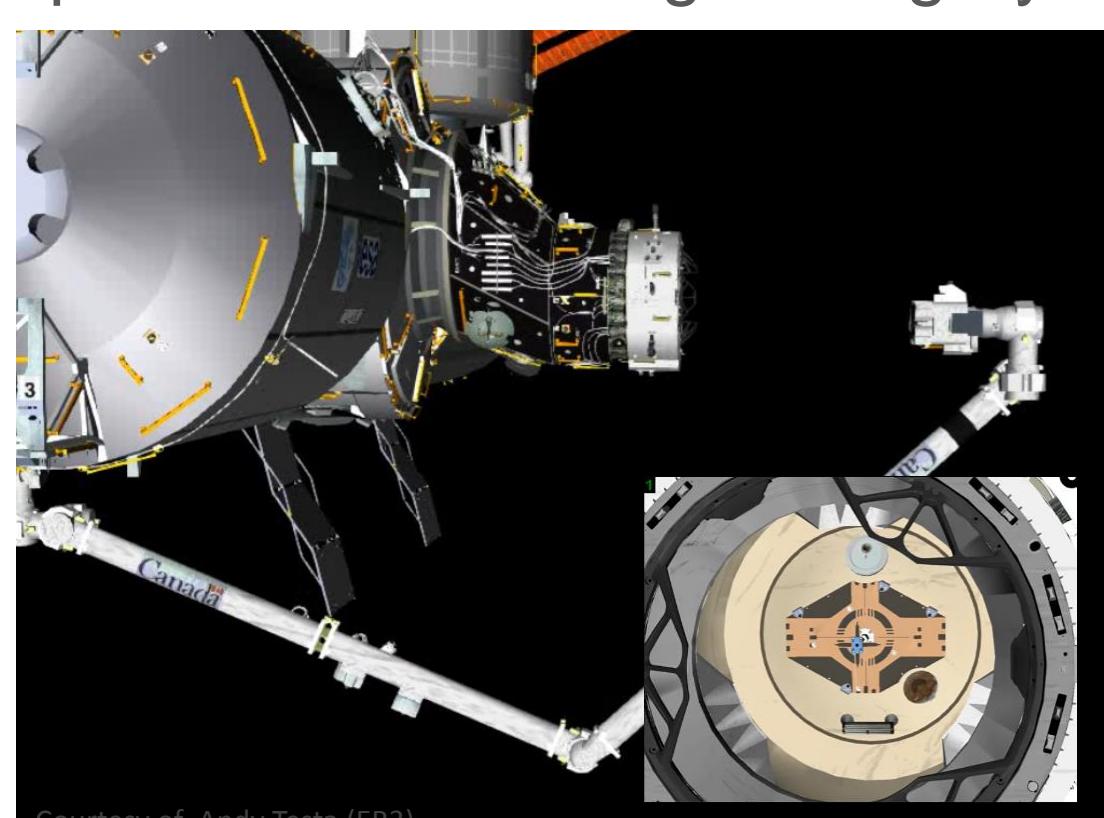
Visual Odometry fills two critical needs shared by all future exploration architectures considered by NASA: Autonomous Rendezvous and Docking (AR&D), and autonomous navigation during loss of comm. To do this, a camera is combined with cutting-edge algorithms (called Visual Odometry) into a unit that provides accurate relative pose between the camera and the object in the imagery. Recent simulation analyses have demonstrated the ability of this new technology to reliably, accurately, and quickly compute a relative pose. This project advances this technology by both preparing the system to process flight imagery and creating an activity to capture said imagery. This technology can provide a pioneering optical navigation platform capable of supporting a wide variety of future missions scenarios: deep space rendezvous, asteroid exploration, loss-of-comm.

## INNOVATION

This technology enables AR&D with only a COTS camera (a significant mass, power, and volume savings over competing AR&D sensors), is extremely computationally efficient compared to competing algorithms, and is extensible to provide autonomous navigation during loss of communications.

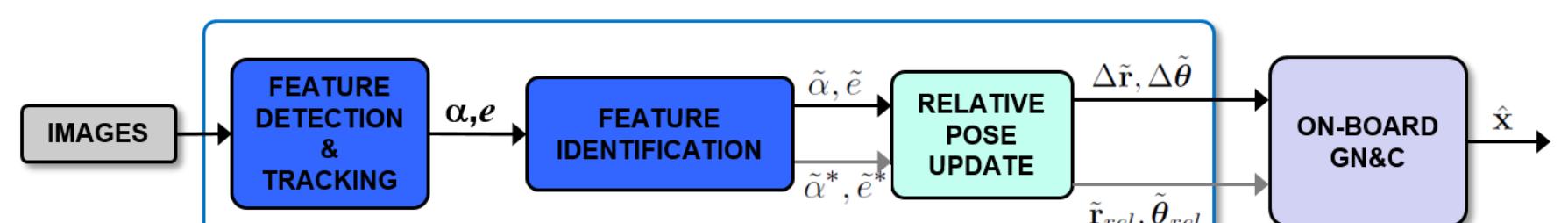
## OUTCOME

- SSRMS path emulating vehicle docking (called the 'ISS Selfie') optimized, validated in simulation, approved by ISS MIP, sent to CSA for flight products, and tentatively scheduled.
- Tool prepared to receive flight imagery and telemetry.

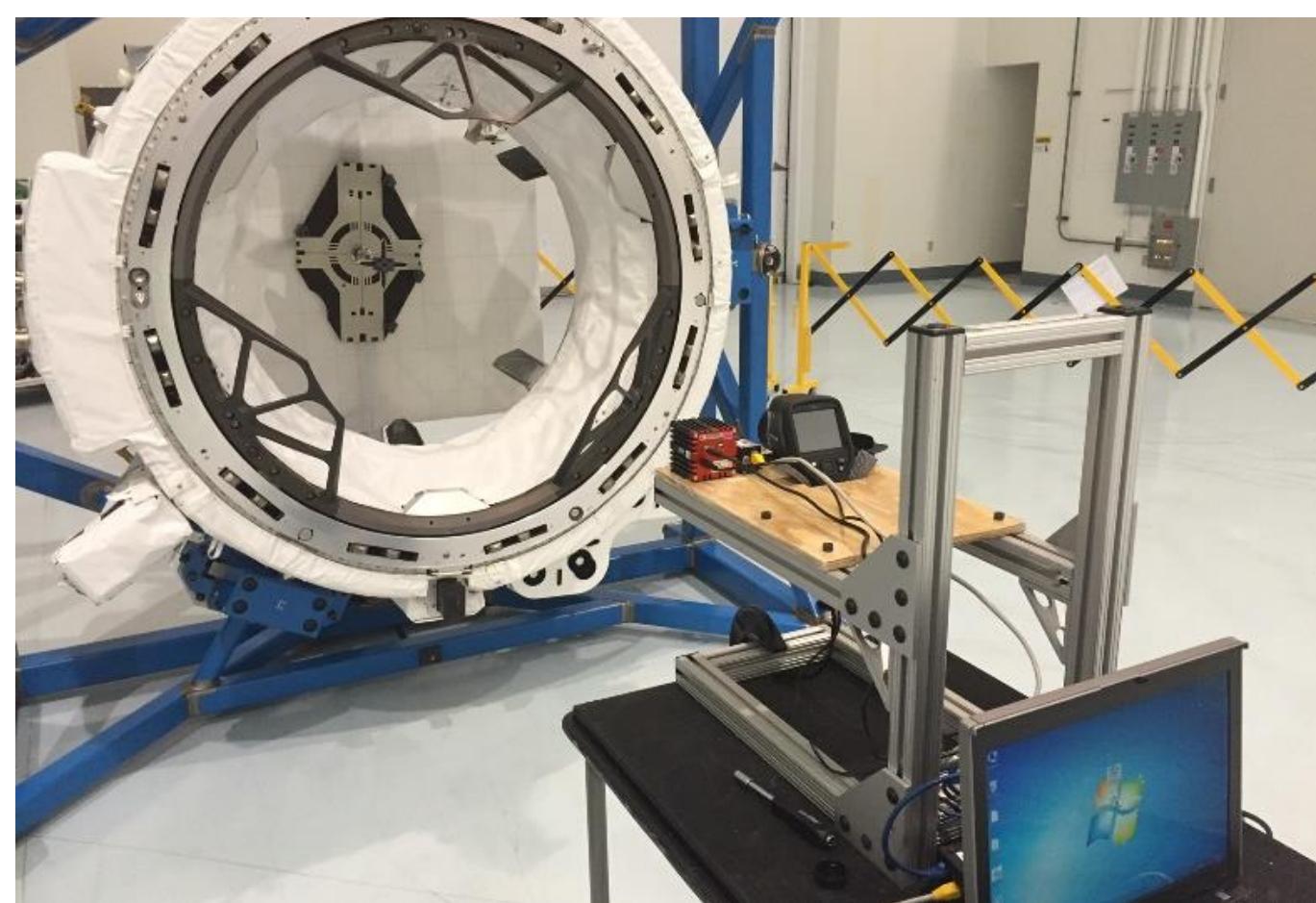


Simulated Imagery of the 'ISS Selfie'

2016 JSC Technology Showcase



Visual Odometry Flow



IDA2 Imagery Acquisition at KSC

## INFUSION SPACE / EARTH

- Orion GN&C engineers are working on this IRD project and see Visual Odometry as an attractive option for Orion's future primary AR&D sensor.
- ISS Robotic Operations engineers are seeking resources to apply this technology to various ISS robotic operations.
- This work expands the capability of current terrestrial navigation systems.

## PARTNERSHIPS / COLLABORATIONS

This technology is built on years of development by Draper Laboratory. During the FY16 development effort, ER3 and CX2 provided simulation analysis and design help for the planned on-orbit activity and proposed further development that applies visual odometry to their needs.

## FUTURE WORK

This technology is ready for a demonstration with on-orbit imagery and telemetry (in work with the 'ISS Selfie'), increasing the TRL beyond 5. With minimal further development, this technology is ready to significantly improve the efficiency of ISS robotic operations.